"On *Bacterium decalvans:* an Organism associated with the Destruction of the Hair in Alopecia areata." By GEORGE THIN, M.D. Communicated by Professor HUXLEY, Sec. R.S. Received February 19, 1881. Read March 3.

[PLATE 3.]

Although Gruby,* in the year 1843, announced that the affection of the hairy scalp known as alopecia areata (area celsi) is caused by a fungus, the parasitic theory of the disease has met with comparatively little support. If the patients on whom Gruby made his observations really suffered from this disease and not from ringworm, which in some of its forms is apt to be mistaken for it, this uncertainty is very remarkable. The fungus, if it exists, should not be difficult of observation, since it is described in his paper as consisting of a sheath of mycelium and spores which accompanies the hair to a distance of 1—3 millims. from the skin. Few competent observers have, however, been able to find a fungus in this disease, and Dr. Michelson, of Königsberg, in an able historical sketch in a recent number of "Virchow's Archiv,"† quotes with approval a statement by Pincus,‡ who avers that up to the year 1869 none of the observations which are relied on as confirming Gruby's observations will stand criticism. The fungus has been sought for chiefly by dermatologists, and in Hebra's text-book of "Skin Diseases,"§ a work of recognised standing, v. Bärensprung, Hebra, Wilson, Neumann, Bœck, Duhring, Scherenberg, and Kaposi are cited as having been unable to find it. The parasitic theory originated by Gruby was noticed less and less by authorities, the disappearance of the hair in patches from a pale uninflamed skin being attributed to a "tropho-neurosis."

Latterly, the question of parasitism has been again raised. Malassez‖ stated in a paper published in 1874 that he had found a fungus, not in the hairs, but on the surface of the epidermis of the diseased parts. There was no mycelium found, but only spores, of which he described three types:—

1. Double-contoured spores, sometimes with a bud (*bourgeon*), 4—5$\mu$ in diameter;

2. Smaller spores, 2—2·5$\mu$ large, single-contoured, some of these also with a bud;

3. Very small, under 2$\mu$ sporules, single-contoured and without buds.

* "Comptes Rendus," 1843, xvii, p. 301.

† Vol. lxxx, p. 296.

‡ "Ueber Herpes tonsurans u. Area Celsi." "Deutsche Klinik," vol. xxi.

§ "Lehrbuch der Hautkrankheiten," vol. ii, p. 150.

‖ "Archives de Physiologie Norm. et Patholog.," 1874.

Eichhorst* states that in nine cases he found spores on the diseased hairs once, between the shaft and root sheaths. There was no mycelium, and the spores were about the size of those of the *Microsporon furfur*. The descriptions given by Gruby, Malassez, and Eichhorst of his solitary case differ from each other; Gruby describing a fungus with mycelium which ensheathes the hair shaft, Malassez single spores of various sizes scattered over the epidermis, and Eichhorst large spores between the hair shaft and root sheaths.

A hypothesis of another kind has been put forward by Buchner.† Considering that the disappearance of the hair in ever-widening circles which bear no relation to the distribution of blood-vessels or nerves, without any evident cause, is best explained by the theory of parasitism, but yet acknowledging the failure of the attempts that have been made to discover the parasite, this observer asks whether the parasite may not be a bacterium, which on account of its smallness and position in the hair cannot be brought under observation. In support of this hypothesis he instances an experiment which he made. In a case of the disease he extracted hairs from the affected patch with heated forceps (so as to exclude contamination to the greatest possible extent), and placed them in a cultivating fluid. He reasoned that if there are bacteria in the hairs they will be in greater number than the bacteria introduced accidentally with the hairs, and that in the first hours of cultivation they would greatly outnumber these latter. Accordingly, he found in eight successive cultivations a bacterium which he describes as a small refractive sharply contoured particle (*Körnchen*), scarcely 0·001 millim. in diameter, with two very fine and short thread-like processes projecting from opposite poles. He remarks that this may not necessarily be the form which the presumed bacterium has in the hair, as the effect of cultivation is sometimes to alter the forms of bacteria.

The observations which are recorded in the following paper were preceded by desultory studies of hairs extracted from patients suffering from this disease during the five years preceding 1880, of which no notes were taken, my attention having been directed to the subject after the appearance of Malassez's paper in 1874.

In none of the hairs, however, which I examined did I discover a fungus. The hairs which I did not have time to examine were put away for future study, carefully folded in paper.

In examining one of the hairs which had been kept for some time, I observed flakes of a filmy substance fall away from the hair, and imbedded in this substance there were what seemed to me to be great numbers of micrococci.

From that time when examining hairs from the margin of patches

* "Virchow's Archiv," vol. lxxviii.

† "Virchow's Archiv," vol. lxxiv.

of this disease I always looked for evidences of the presence of bacteria. The difficulty of distinguishing in a fluid minute granules from micrococci or from the spore forms of rod bacteria, is so great, that it was only when the characteristic appearances of elongating spheroids or small rod-shaped bodies containing spheroidal elements, arranged linearly, or rod bacteria were observed, that the evidence of the presence of organisms was deemed conclusive. These were, however, observed sufficiently often to satisfy me that their presence was probably more than accidental, and to induce me to submit the affected hairs to various processes with the view of enabling the contents of the hair shaft to be better observed.

During the year 1880 six cases were specially utilised for this purpose, and, as in all these cases, a considerable number of hairs, in several of them a large number, were examined and submitted to methods of examination eminently fitted to display a fungus, if such were present, it may be useful to state in further confirmation of the opinions generally entertained, that in none of them any more than in those previously observed, was any fungus discovered.*

All these six cases were unmistakable examples of alopecia areata. Evidence that this was so would be out of place in this paper, but will be given in due time in a professional journal in connexion with a description of the treatment under which the disease was in all of them at once arrested.†

The treatment referred to was based on the evidence which, by this time I believed I had obtained, that the progress of the disease was due to the development of a bacterium.

In utilising these cases for the demonstration of an organism, my object was not so much to observe bacteria in fluids in which the hairs were examined, as to endeavour to find some method by which their presence could be shown in the substance of the hair. In five of the six cases I satisfied myself that this had been done. This demonstration is attended with great difficulty. In a comparatively sound hair it is very difficult to bring minute objects like bacteria under observation, and in hairs which are considerably affected the shaft is found, when prepared for examination, to be so full of pigment and other granules that it becomes very difficult to distinguish organisms amongst them, presuming these to be present.

The methods employed were the following:—

* The extent to which these investigations have been carried, more especially as regards the number of hairs examined in some of the cases, leads me to believe that those authors who have described a fungus in alopecia areata made a mistaken diagnosis, and that their cases were examples of ringworm in which the growth of the trichophyton had produced comparatively little reaction in the skin.

† As I am familiar with the disease, for the purposes of this paper my statement as regards the diagnosis may be considered sufficient.

1. The hairs when extracted were placed for a short interval in potash solution (the strength used varied from 5 to 20 per cent.); they were then washed in distilled water, and passed successively through absolute alcohol and ether. After being thoroughly subjected to the action of ether they were again placed successively in alcohol and distilled water, and were then finally mounted for examination in diluted Goadby's solution.*

The object of these manœuvres was to make the hair transparent, free it from oily particles, and finally mount it in a medium suitable for the detection and preservation of any organisms which it might contain. The method was not perfectly nor always successful, but in some instances it sufficed to show objects within the cuticle of the hair, which I believe it is justifiable to consider as bacteria.

2. The extracted hairs were at once examined in the Goadby's solution.

3. The hairs were placed successively in absolute alcohol, oil of cloves, and dammar varnish, in which they were examined.

4. Hairs kept for future examination in Goadby's solution, and in a 5 per cent. solution of carbolic acid were at convenient times, after being soaked for a little while in distilled water, subjected to the alcohol, oil of cloves, and dammar process.

In all cases precautions were taken to prevent the development of organisms after the hairs were extracted.

Attempts to show the presence of bacteria in the hairs by staining with methylaniline were defeated by the intensity with which the hair itself was stained with this dye.

The result of the examinations of a large number of hairs prepared by these methods has been to satisfy me that minute objects can be detected in them similar in size and form to those which I had recognised as organisms on the borders of freshly-extracted hairs, and preparations were obtained in which these objects were found in positions, and so arranged as to show that they were distinct from the rows and aggregations of minute granules which are found in healthy hairs.

The objects referred to were seen either as round or as elongated rounded bodies, and resembled in shape and in their refractive qualities the elements which I have described as cocci in a paper on *Bacterium fœtidum* ("Proc. Roy. Soc.," No. 205, 1880). In the preparations put up in dammar varnish these bodies were not liable to be mistaken for oily particles or crystals, which were not present in the hairs. In the preparations put up in Goadby's solution, in spite of the care which had been taken to soak the hairs in ether, oily

* The following is the formula:—Bay salt, 12 ounces; burnt alum, 6 ounces; corrosive sublimate, 15 grains; water, 1 gallon. Dissolve and filter. I have found it an excellent medium for mounting.

particles were present to such an extent as frequently to make accurate observations impossible.

In some hairs, however, this mode of preparation had produced results which were most instructive.

The effect of the potash and other treatment had been to get quit of the whole contents of the cuticle at some parts, the cuticle being then seen as a transparent membrane.

At these parts the minute objects I have described were found clustered on the inner surface of the membrane. In all the hairs in which they were found, and in all the patients, these bodies were the same in size, and refracted light in the same way. They were found frequently in pairs, the long axis of each member of the pair forming a continuous line. Sometimes three of them were found end to end with an appearance of one continuous sheath for the three. These appearances are characteristic of bacteria in development.

In seven cases in which a treatment was applied that was designed to arrest the development of organisms, and mechanically to prevent their being transported from one hair to the other, the disease at once ceased to spread. In one case, whilst the patches under treatment had been arrested, and new hairs were coming on them, two other patches had appeared unobserved on other parts of the head.

The same treatment at once arrested the growth of these new patches.

I have taken much pains to represent the size of these bodies by means of camera drawings, and I believe I have succeeded fairly well; but I confess to have found it very difficult to get the exact size. As many measurements made of the same objects agreed with each other I believe the drawings may be taken as a guarantee, both of size and shape.

In order further to ensure accuracy in this respect I obtained the kind assistance of Mr. Noble Smith, whose capacity as an accurate draughtsman in all that relates to microscopic objects is recognised and appreciated. Fig. 2 was prepared from a drawing by Mr. Smith. He determined the outlines of the hair, and drew a number of the objects (or organisms) to the size in which he saw them. The others were filled in to the scale determined by Mr. Smith. The magnifying power represented in the drawing was estimated by measuring the hair.

Clusters of the organisms were also found in dammar preparations in which the hair was found split into shreds. These shreds were sometimes so thin that the objects which I am describing were seen with much distinctness.

The order of development of the organisms, or the different stages of their action in breaking up the hair shaft, I believe to be indicated by the appearances which I have figured in the drawings. In

fig. 1 there is represented what I believe to be an early stage, the earliest which I have observed. A cluster of bacteria is seen on the surface of the hair shaft, but under the cuticle of the hair, whilst on the side of the hair others are seen embedded in granular *débris*, probably remains of the inner root sheath. The shaft of the hair is unbroken.

In fig. 2 great numbers of bacteria are seen near the root of a hair. By regulation of the fine adjustment the position of the bacteria could be accurately made out. A considerable length of the root sheath had come away with the hair, completely investing it. The bacteria were found in a circular layer between the root sheath and the shaft of the hair. They had neither penetrated the root sheath nor the shaft. Fig. 4 indicates the position of the organisms as they are seen when the centre of the hair is brought into focus: the drawing being on too small a scale to show the individual bacteria their position has been shown by dark shading. In fig. 5 the dark shading shows the position of the bacteria when the lower surface of the hair is brought into focus. By comparing these three figures with each other, the arrangement of the bacteria becomes apparent. In fig. 6 part of a hair is represented in which the removal of the substance of the hair shaft has shown a number of organisms disseminated over the inner surface of the cuticle. They were traced towards the thick unemptied part of the hair, in which they became lost in a thick granular mass. In fig. 7 a hair is shown in which organisms were found immediately under the cuticle.

I infer from all these appearances that the bacterium penetrates downwards between the internal root sheath and the shaft. Towards the root of the hair it penetrates the hair substance, and as it multiplies it ascends upwards in the substance of the hair. The breaking up, loosening, and disappearance of the hair is to be attributed to the disorganisation of the hair substance by the growing organisms, for it is impossible to suppose that a free development of bacteria could take place in the shaft of a hair without the substance being decomposed and its integrity destroyed.

This is the inference which it seems to me follows naturally from the detection of organisms in the diseased hairs in alopecia areata. It might be alleged that it has not been shown that the composition of the hair is not altered by some supposed error of nutrition, and that bacteria find in these abnormal hairs a soil in which they can thrive. No such alleged nutritive change has ever been shown to exist, and I believe that the existence of an object of a definite size and form having the characteristic appearance of a bacterium, and now ascertained for a certain although a small number of cases, will afford to workers in similar fields strong presumptive evidence that its presence is the key to the mystery in which the disease has been shrouded. In

Fig. 1.

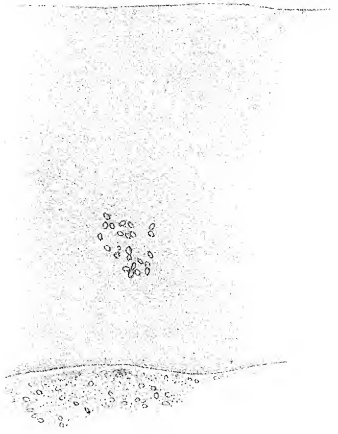
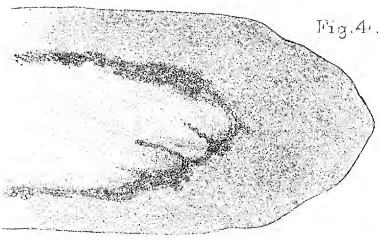


Fig. 4.



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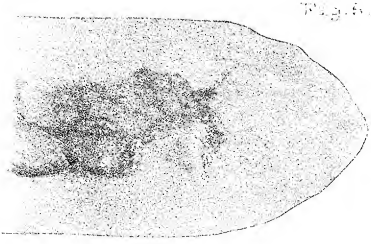

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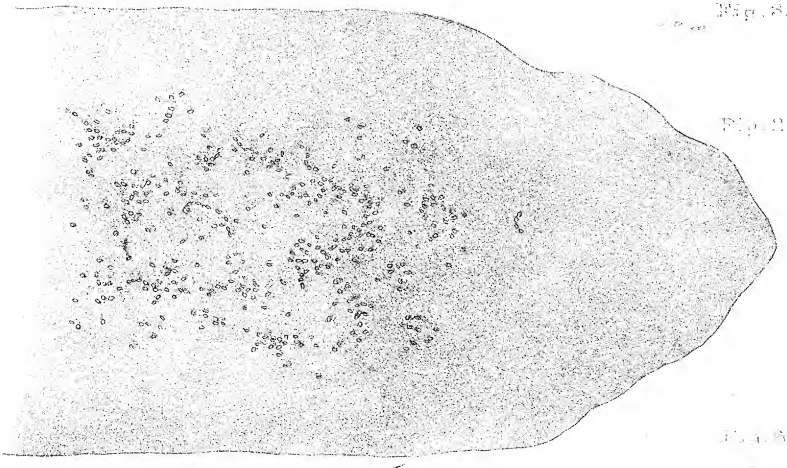
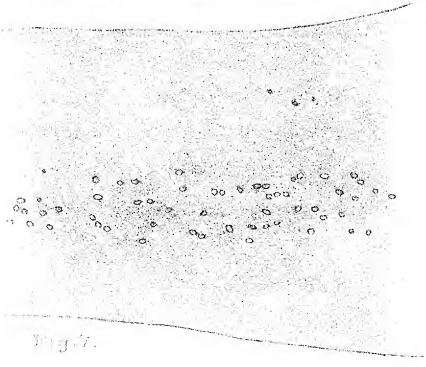


Fig. 2.

Fig. 3.



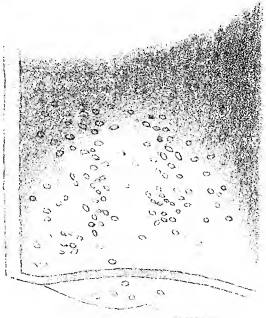


Fig. 7.

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extracting hairs for examination I took them from a considerable breadth of margin, and as the proportion of the hairs examined which showed any change or evidence of organisms was small, it is probable that these are present only in a narrow zone, and that after a hair is once attacked development takes place rapidly and the hair soon falls.

It may be well to divide the statements made in this paper into two heads; those which relate to ascertained facts, and those which relate to a theory of the causation of alopecia areata, which I believe is sustained by these facts:—

1. The facts are that minute bodies of definite and fixed shape and size are found in and on the hairs in alopecia areata. These bodies are distinct from the granular elements present in hairs, and are neither oily particles nor crystals. They are of the size and shape, and have the refractive qualities of bacteria. When present in small numbers on the shaft the hair is entire, whilst within some hairs much affected by the disease they were found in great numbers.

2. The theory is that these bodies are bacteria, and that the disappearance of the hair is due to a breaking up of the hair shaft by the multiplication in it of the organisms.

As I believe it is desirable to give to definite objects like those which I have described a name which will mark their association with the theory I have founded on them, and as I am myself satisfied as to their nature, I suggest the term *Bacterium decalvans* as a convenient designation.

## DESCRIPTION OF PLATE 3.

Figure 1. Case of S. B. A small group of organisms on the shaft of the hair, under the cuticle. Others are seen scattered in a granular mass which is adherent to the hair.
(Camera drawing.) × 600.

Figure 2. Case of I. F. Organisms between the root-sheath and the shaft of the hair near the root. (Drawn by Mr. Noble Smith.)
× about 470.

Figure 3. Organisms from the group shown in fig. 2, more highly magnified.
(Camera drawing.) × 560.

Figure 4. The hair shown in fig. 2, the focus being now in the axis of the hair. The position of the organisms is indicated by the dark shading.

Figure 5. The hair shown in fig. 2 when the focus is carried down to the under surface, the position of the organisms being again indicated by the dark shading.

Figure 6. Case of S. B. In a part of the hair from which the substance of the hair-shaft has disappeared and the cuticle left empty, organisms are seen lying on the internal surface of the cuticle.
(Camera drawing.) × 880.

Figure 7. Case of N. S. Organisms on the shaft and beneath the cuticle.
(Camera drawing.)